



# **THE GREAT LAKES**

## **“Sustainable or Unsustainable?”**

*The purpose of this lesson is to understand some of the factors that negatively affect the sustainability of aquatic ecosystems. I believe that it is important for students to become familiar with regional environmental issues, so I chose to have them investigate case studies that illustrate these issues. The group activity, visual diagram and visual organizer were used to help simplify the information provided in the case studies. The MISSING! assignment is important because it emphasizes the importance of protecting ecosystems and helps students realize their own potential in the cause.*

### **A. Ministry Expectations**

#### **Overall Expectations:**

- demonstrate an understanding of the dynamic nature of ecosystems, including the relationship of ecological balance and the sustainability of life
- investigate factors that affect ecological systems and the consequences of changes in these factors
- analyse issues related to environmental sustainability and the impact of technology on ecosystems

#### **Specific Expectations:**

##### *Understanding Basic Concepts*

- examine the factors (natural and external) that affect the survival and equilibrium of populations in an ecosystem
- examine how abiotic factors affect the survival and geographic location of biotic communities

##### *Developing Skills of Inquiry and Communication*

- through investigations and applications of basic concepts:
- formulate scientific questions about observed ecological relationships, ideas, problems, and issues
- select and integrate information from various sources, including electronic and print resources, community resources and personally collected data, to answer the question chosen
- analyse data and information and evaluate evidence and sources of information, identifying flaws such as error and bias
- select and use appropriate vocabulary and numeric, symbolic, graphic, and linguistic modes of representation to communicate scientific ideas, plans, results and conclusions

##### *Relating Science to Technology, Society and the Environment (STSE)*

- assess the impact of technological change and natural change on an ecosystem
- identify and research a local issue involving an ecosystem; propose a course of action, taking into account human and environmental needs; and defend their position in oral or written form;
- identify and evaluate Canadian initiatives in protecting Canada's ecosystems

## **B. Lesson Plan**

### **1. The Great Lakes Case Studies Activity – Think/Pair/Share (see Appendix 1)**

*(requires 1-2 class periods)*

- Students are organized into 8 groups and each group is given one of the Great Lakes Case Studies Cards.
- Each student is given the Great Lakes: Case Studies Handout, which includes activity directions and a summary table.
- In groups, students read and discuss the case studies and answer the questions provided. Using chart paper, the students create diagrams (e.g. timeline, cycle diagram, then and now picture, etc.) to summarize the issues covered in the case study and provide answers to the discussion questions. The diagrams will be used to present the case study to the class.
- Each group shares their case study with the class in a 3-5 minute presentation. Students complete the summary table for each of the case studies during/after the class presentations.

### **2. MISSING! Assignment – Individual Performance Task (see Appendix 2)**

*(requires at least 1 period of class time for individual research)*

- Each student is given the MISSING! Assignment Handout, which includes a description of the assignment, details of the assignment, evaluation details, references, and a rubric. The teacher should have access to the internet to show the students the List of Wildlife Species at Risk and other references, and explain the details to the students.
- Each student should also be given (randomly or selected) one of the 40 species from the Species Topics for Students.
- Students should be given class time to research their species on the internet and prepare their MISSING! poster.

## **C. Evaluation**

### **Formative assessment:**

- oral questioning, observation, discussion, participation, note taking, and presentation during the Great Lakes Case Studies Activity.
- oral questioning and observation during research for the MISSING! Assignment.

### **Summative assessment:**

- evaluation of the MISSING! Poster using the rubric provided.

## **D. Key Questions**

1. What is the largest readily available source of freshwater in the world?
2. Are the Great Lakes a sustainable or unsustainable aquatic ecosystem?
3. What are some of the current issues threatening sustainability of the Great Lakes ecosystem?
4. What can individuals/societies do to preserve the sustainability of aquatic ecosystems?
5. What is the common consequence of factors that negatively affect the sustainability of ecosystem?

## **E. Appendices**

### **Appendix 1: Great Lakes: Case Studies Activity**

- Student handout including activity instructions and summary table (visual organizer)
- Great Lakes Case Studies cards

### **Appendix 2: MISSING! Assignment (Great Lakes Species at Risk)**

- Assignment for Summative Evaluation
- Student handout (including Rubric for assessment)
- Species topics for students

## **F. Additional Resources**

Grady, Wayne. The Great Lakes: The Natural History of a Changing Region. Vancouver: Greystone Books, 2007.

The Species at Risk Public Registry – A to Z Species Index (Government of Canada)  
[http://www.sararegistry.gc.ca/sar/index/default\\_e.cfm](http://www.sararegistry.gc.ca/sar/index/default_e.cfm)

# GREAT LAKES: CASE STUDIES



**Current issues that are threatening the sustainability of the Great Lakes ecosystem.**

## **PART 1 – Investigating One Case Study (20 minutes)**

**Each group will be given one case study that explains an issue that is threatening the sustainability of the Great Lakes ecosystem.**

- a) READ - As a group, read the case study.
- b) DISCUSS – As a group, discuss the following questions and record your answers in the table on the following page. Provide at least one answer to each question.
  - What is the cause?
  - What are the immediate consequences?
  - What are some of the possible long-term or future consequences?
  - How might individuals and/or societies help resolve the situation?
  - How might individuals and/or societies help prevent similar situations from happening in the future?
- c) CREATE A DIAGRAM - As a group, create a diagram on the chart paper provided that you will use to help summarize the issue covered in your case study and your answers to the questions in b), when you present your case study to the class (3-5 minute presentation). You may choose to use a timeline, a cycle diagram, a picture of then and now, or any other type of diagram, as long as the diagram clearly demonstrates the cause and consequences of the issue. The possible solutions/prevention strategies do not have to be included in the diagram, but should be discussed when you share your case study with the class.

## **PART 2 – Sharing the Case Studies with the Class (3-5 minutes each)**

**Each group will share their case study with the class, so that everyone can complete the table on the following page.**

- a) SHARE - As a group, share your case study with the class. Each member of the group must contribute in the explanation to the class. Be sure to include the following:
  - The title of your case study (the issue) and any necessary definitions.
  - Use your diagram to explain the cause, and the immediate and future consequences.
  - Explain at least one of the possible solutions and one of the possible prevention strategies that you discussed in your group.
- b) COMPLETE – Individually, complete the table on the following page during the case study presentations using the information provided by each group.

# Great Lakes: Case Studies #1-3

Current issues that are threatening the sustainability of the Great Lakes ecosystem.

Issue	Cause	Consequences		Individual/Society Action	
		Immediate	Future	Solution	Prevention
<b>1. Eutrophication</b> Example:					
<b>2. Invasive Species</b> Example:					
<b>3. Toxic Contaminants</b> Example:					

## Great Lakes: Case Studies #4-6

Issue	Cause	Consequences		Individual/Society Action	
		Immediate	Future	Solution	Prevention
<b>4. Habitat Loss</b> Example:					
<b>5. Overfishing</b> Example:					
<b>6. Climate Change</b> Example:					

## Great Lakes: Case Studies #7-8

Issue	Cause	Consequences		Individual/Society Action	
		Immediate	Future	Solution	Prevention
<b>7. Pathogens</b> Example:					
<b>8. Water Removal</b> Example:					

## **EUTROPHICATION**

In the 1960's Lake Erie was declared "dead" as a result of eutrophication. Nutrient pollution or eutrophication occurs when there is a build-up of nutrients, typically compounds containing nitrogen or phosphorous, in an ecosystem. In the case of Lake Erie, phosphorous from fertilizers and commercial detergents that were concentrated in the lake as a result of sewage and run-off were found to be the main culprits.

Eutrophication of Lake Erie led to a rapid increase in the growth of algae and other weedy species on the surface of the lake. This prevented sunlight from penetrating to deeper waters, and plants below the surface began to die because they were unable to carry out photosynthesis. Without plants to produce oxygen, the oxygen concentrations in the water decreased dramatically. A further decline in oxygen was caused by an increase in the decomposer population, which resulted from the presence of extra dying and decaying plant matter. These low oxygen conditions produced an uninhabitable environment for many of the lakes plant and animal species, leading people to declare the lake "dead".



# 1. EUTROPHICATION



A satellite image of Lake Erie taken by the NOAA Great Lakes Environmental Research Laboratory, on April 15, 2005. Research efforts by the laboratory have focused on the effects of oxygen depletion on food-web interactions and fish production and the causes of harmful algal blooms in the lake.

## **INVASIVE SPECIES**

As of October 2008, the National Center for Research on Aquatic Invasive Species (NCRAIS) has identified a total of 186 invasive species in the Great Lakes and surrounding drainages. Invasive species are non-indigenous species that adversely affect the habitats they invade economically, environmentally or ecologically.

It has been over twenty years since the initial discovery of invasive zebra mussels in the Great Lakes. The zebra mussel is a small freshwater bivalve mollusk native to the Black and Caspian Seas of eastern Asia, and is one of the most notorious aquatic invasive species to enter North America. It is believed that they were inadvertently introduced into Lake St. Clair via the discharged ballast water of transoceanic ships and have since colonized all of the Great Lakes.

The negative impact of zebra mussels is several-fold. First of all, zebra mussels adhere to all types of substrates such as boats, water-intake pipes, docks, piers, and each other forming dense layered colonies up to one foot thick. The financial costs associated with controlling these infestations are substantial. In addition, zebra mussels also adhere to native mussels, essentially smothering them in the process. The primary food source for zebra mussels is phytoplankton, which they obtain by filter-feeding. Native mussels and other animals that eat phytoplankton have been adversely affected by competition with the zebra mussels for food, and several are now in danger of extinction.

Zebra mussels have also had positive impacts on parts of the Great Lakes ecosystems. Several native species of fish, birds and other animals utilize zebra mussels as a food source. In addition, the filter-feeding zebra mussels cleanse the water, increasing the penetration of sunlight and filtering out pollutants.

## 2. INVASIVE SPECIES



A picture of a zebra mussel, *Dreissena polymorpha*, encrusted current meter retrieved from Lake Michigan, taken in June 1999.

## **TOXIC CONTAMINANTS**

Environment Canada estimates that there are over 360 toxic chemical compounds that have been identified in the Great Lakes. The 1978 Great Lakes Water Quality Agreement defined a toxic substance as any substance that can cause disease, behavioral abnormalities, cancer, genetic mutations, physiological or reproductive malformations or physical deformities in any organism or its offspring, or which can become poisonous after concentration in the food chain or in combination with other substances. Toxic chemicals are released into the Great Lakes by directly discharging them into the lakes, through runoff and groundwater, and by deposition from the atmosphere.

Persistent toxic chemicals are particularly hazardous due to their tendency to accumulate in organisms, a phenomenon referred to as bioaccumulation. The bioaccumulation within individual organisms may be compounded through several levels of a food chain, a process called biomagnification. These phenomena were brought to light in the 1960's when the reproductive failure of several species of predatory birds led to a massive decline in population numbers. The culprit was DDT, a pesticide whose discovery won the scientist Paul Muller the Nobel Prize in 1948, and whose effectiveness and inexpensiveness led quickly to its use around the globe. Measurements of DDT levels in aquatic ecosystems revealed the magnification of DDT concentrations at each successive level of the food chain, such that concentrations were several million times higher at the top of the food chain. These concentrations were not directly lethal to the highest order consumers, but did impair their reproduction by interfering with the body's ability to retain calcium. As a result, the birds produced eggs with significantly thinner shells that were often too thin to bear the weight of the adult during incubation.



### 3. TOXIC CONTAMINANTS



DDT interferes with the body's ability to retain calcium. As a result the eggshells of contaminated birds are often too thin to bear the weight of the adult during incubation.

## **HABITAT LOSS**

The Great Lakes basin is home to millions of acres of wetlands. A wetland is a transitional zone in which the water table is at the same height as or slightly higher than the surrounding land. Wetlands, including swamps, marshes, fens, and bogs, are unique ecosystems that are important wildlife habitats for many species of plants, fish, reptiles, songbirds, amphibians, and migratory waterfowl. Unfortunately, more than 70 percent of southern Ontario's wetlands have been drained since the pioneer days resulting in a major loss in biodiversity.

The wetlands in the Great Lakes basin are a vital link in the routes of many migratory waterfowl, offering resting places, food sources, protection from predators, and nesting spots. One such bird is the Canada Goose. The wetlands of the Great Lakes are an important breeding area for Canada Geese, who migrate up from wintering areas in the spring. Habitat loss in the late eighteenth to early nineteenth century was one of the factors contributing to near extinction of the Giant Canada Goose in southern Canada and the northern United States. In fact, by the 1950's the Giant Canada Goose was thought to be extinct, until a small flock was discovered wintering in Rochester, Minnesota. In recent years, Canada Geese populations have grown so substantially that they have become a nuisance in many areas, making the story of the Canada Goose in the last hundred years one of controversial success.

## 4. HABITAT LOSS



The wetlands in the Great Lakes basin are a vital link in the routes of many migratory waterfowl, such as the Giant Canada Goose, *Branta canadensis*.

## **OVERFISHING**

Prior to the arrival of Europeans, there were 150 different species of fish in the Great Lakes, an important natural resource in the Great Lakes region. According to the Government of Ontario, the Great Lakes now support a \$100 million dollar commercial fishing industry and a \$350 million dollar recreational fishing industry. Today, the Great Lakes fishery includes native and introduced species, some of which are regularly stocked. Over the years, exploitation of these fish stocks has threatened the biodiversity in one of the world's most important inland fisheries.

The largest fish in the Great Lakes is the lake sturgeon, an ancient species that can weigh up to 136 kilograms, grow up to 2.4 meters or more, and live for more than one hundred years. Lake sturgeon were abundant in all of the Great Lakes prior to the eighteenth century, so abundant in fact that they were considered to be a pest by commercial fishermen. Since they were not sold and were thought to be responsible for killing more valuable fish, lake sturgeon carcasses were fed to animals, used as fertilizer, and burned in the boilers of steamboats. In 1860 a fish plant in Ohio began selling smoked sturgeon and lake sturgeon caviar and the commercial value of lake sturgeon increased dramatically by the 1880's. In 1880, the Ohio plant alone caught 3.2 million kilograms of sturgeon. As a result, the lake sturgeon population plummeted, a decline that was obvious throughout the Great Lakes by the 1900's. The fact that these fish require up to 20 years to reach sexual maturity and reproduce only once every four years has made population comeback a slow process. The lake sturgeon is still listed as either threatened or endangered throughout the Great Lakes under the Species at Risk Act, assessed by the Committee on the Status of Endangered Wildlife in Canada.



## 5. OVERFISHING



Lake sturgeon are the largest fish in the Great Lakes. Once one of the most abundant fish species in the Great Lakes, lake sturgeon are now rarely seen. Overfishing in the eighteenth century was largely to blame for the dramatic decline in the population.

## **CLIMATE CHANGE**

The Nature Conservancy of Canada and Environment Canada predict that the temperature in the Great Lakes region will rise between 3°C and 10°C as a result of global warming. This altered climate will transform the Great Lakes ecosystem immensely. Some of the likely scenarios predicted by scientists include increased evaporation, reduced ice cover, decreased precipitation, lower water levels, increased water temperature, and local extinctions.

Warmer water temperatures have already been implicated in the low reproduction rate of cold-water fish species, such as the Atlantic Salmon. Atlantic Salmon populations were initially devastated by overfishing and the construction of dams that disrupted spawning patterns, but global warming has been blamed for the lack of success of restocking efforts. Landlocked salmon migrate up rivers and streams to deposit and fertilize their eggs, also known as spawning. Global warming does not have an effect on the spawning times, which are determined by the number of hours of daylight. However, water temperature does have an effect on the success of spawning, including the number of hatchlings that survive and the ratio of male to female hatchlings. Fisherman have long known that cold water at spawning time will result in large numbers of cold-water-spawning species. Furthermore, only slight variations of a fraction of a degree above or below normal temperature can have significant effects on the population of fish in a given year.

As cold-water species decline, warm-water fish including most non-indigenous species will thrive. These warm-water intruders many contribute to the decline in cold-water populations by competing with the native species for food and habitat.

## 6. CLIMATE CHANGE



Landlocked Atlantic Salmon migrate up streams and rivers to deposit and fertilize their eggs, also known as spawning. The success of spawning is largely determined by water temperature. Recently, global warming has been implicated in the failure of recent Atlantic Salmon restocking efforts in the Great Lakes region.

## **PATHOGENS**

A pathogen is an infectious agent that causes disease or illness to its host and includes viruses, prions, bacteria, fungi, and protozoa. The major sources of introduction of pathogens into the Great lakes are direct discharge of untreated sewage into waterways and the discharged ballast water of transoceanic ships. Waterborne pathogens pose a threat to public health and affect the health and biodiversity of aquatic ecosystems.

One such pathogen is the virus that causes viral hemorrhagic septicemia (VHS), a deadly infectious fish disease. The disease destroys the linings of blood vessels causing hemorrhaging (bleeding) of internal organs, skin, and muscle of infected fish. External signs of infection include bulging eyes, pale gills, bleeding around the eyes, bases of the fins, sides and head, darkening of overall color, distended belly and corkscrew swimming behavior, but may not be present in all infected fish. The virus is highly contagious and can be spread from fish to fish through bodily fluids that are released into the water, through contaminated eggs, and by eating infected fish. There are no signs that the disease affects human health, but people have been advised not to eat infected fish.

VHS is considered an invasive species (not native to the Great Lakes), but it is not known how the disease arrived. VHS was first detected in the Great Lakes region in 2003 and has since killed tens of thousands of fish in the region. The virus has been implicated in the mass mortalities of at least twelve species found in the Great Lakes, including muskellunge, freshwater drum, round goby, smallmouth bass, bluegill, crappie, yellow perch, walleye, white bass. However, nearly 50 species of fish are known to be susceptible to VHS. The full effect of VHS remains to be seen, but the environmental and economic impact from large die-offs of fish in the Great Lakes region could be profound.

## 7. PATHOGENS



Viral Hemorrhagic Septicemia (VHS) is a deadly infectious fish disease that causes hemorrhaging (bleeding) of the internal organs, skin, and muscles of infected fish. Since its arrival in the Great Lakes Region in 2003, VHS has been implicated in the death of tens of thousands of fish.

## **WATER REMOVAL**

Together, the Great Lakes contain 20 percent of the Earth's freshwater, the largest readily available source of freshwater in the world. The Great Lakes have always been viewed as an important source of water for drinking and route for transportation, however more recently water has become more of a commodity and has been aptly named the "blue gold" of the 21<sup>st</sup> century. Around the mid-nineteenth century, massive amounts of water were beginning to be withdrawn from the Great Lakes not only for drinking, but also for growing domestic and public use, industrial and commercial use, thermoelectric power use, and for agriculture.

The largest diversion of water out of the Great Lakes basin is the Chicago Diversion, completed in 1900, that diverts water from Lake Michigan into the Mississippi River, which empties into the Gulf of Mexico. During the 1920's, the Chicago diversion removed as much as 24 billion liters of water per day from the Great Lakes. Residents became concerned when water levels in the Lake Huron-Michigan Basin began to decline, reaching a record low in 1964. The U.S. Supreme Court responded by limiting the removal of water to 7.6 billion liters per day. However, there have been disputes over the years with the state of Michigan claiming that more water has been diverted than was allowed by the court decree. The demands for water will likely rise in the coming decades with population increases and global warming. This is becoming evident with the number recent proposals to use, divert, and remove large quantities of water from the Great Lakes.

The primary consequence of the removal of water from the Great Lakes Basin is permanently lowered lake levels. In addition to social and economic impacts, lowered lake levels will also have a significant impact on the environment. Possible environmental impacts may include, but are not limited to, reduced water quality and loss of wetland habitats.



## 8. WATER REMOVAL



Water diversions into and out of the Great Lakes Basin, as summarized in the International Joint Commissions final report entitled, "Protection of the waters of the Great Lakes" submitted to the Governments of Canada and the United States on February 22, 2000.

# **GREAT LAKES CASE STUDIES**



**Current issues that threaten  
the sustainability of the  
Great Lakes ecosystem.**



# **GREAT LAKES: CASE STUDIES**

## **1. Eutrophication**

- Lake Erie

## **2. Invasive Species**

- Zebra Mussels

## **3. Toxic Contaminants**

- DDT

## **4. Habitat Loss**

- Giant Canada Goose

## **5. Overfishing**

- Lake Sturgeon

## **6. Climate Change**

- Atlantic Salmon

## **7. Pathogens**

- Viral Hemorrhagic Septicemia

## **8. Water Removal**

- Chicago Diversion

# MISSING!

## Assignment

### Great Lakes Species at Risk



#### Description of the Assignment

Each student will create a “MISSING! Poster” for one species from the Great Lakes aquatic ecosystem that is currently on the Canadian List of Wildlife Species at Risk. The posters will be displayed in the classroom to inform other students about some of the existing threats to biodiversity in the Great Lakes region.

The List of Wildlife Species at Risk<sup>1</sup> is a list maintained by the Government of Canada, based on a report from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), an independent committee of wildlife experts and scientists. The list classifies species at risk under five categories: special concern, threatened, endangered, extirpated, and extinct. The definitions below come directly from COSEWIC’s Assessment Process and Criteria<sup>2</sup>.

**Extinct** – A wildlife species that no longer exists.

**Extirpated** – A wildlife species that no longer exists in the wild in Canada, but exists elsewhere.

**Endangered** – A wildlife species likely to become endangered if limiting factors are not reversed.

**Threatened** – A wildlife species likely to become endangered if limiting factors are not reversed.

**Special Concern** – A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.

The List of Wildlife Species at Risk is part of the Species at Risk Act (SARA)<sup>3</sup>. According to the Government of Canada the goals of SARA are to prevent wildlife species from becoming extinct or extirpated, help in the recovery of extirpated, endangered or threatened species, and ensure that species of special concern do not become endangered or threatened. Recovery strategies are developed and implemented by SARA to meet these goals.

One of the components of SARA is an A to Z species index<sup>4</sup>, which provides a profile of each species on the List of Wildlife Species at Risk and a summary of recovery initiatives.

**“All Canadians have a shared responsibility to protect species at risk and ensure healthy ecosystems for future generations.”**

*- The Species at Risk Act & You (by the Government of Canada)<sup>5</sup>*

**Details of the Assignment****Due Date:** \_\_\_\_\_**1. The Species**

The species will be assigned in class.

**Your Species:** \_\_\_\_\_ (common name)  
\_\_\_\_\_ (scientific name)

**2. The “MISSING! Poster”****a. General specifications:**

- Use 8 ½ x 11 inch (letter size) or 8 ½ x 14 inch (legal size) paper of any color to make the poster.
- The poster should include both text and graphics.
- All text should be computer generated, with the exception of the main title that can be neatly written/drawn by hand.
- Graphics and graphic details (borders, etc.) can be either hand drawn or computer generated.

**b. The MISSING! Poster must include the following:**

- Student name and date – on the front or back of the poster
- Main title – “MISSING!”
- The status of the species according to SARA
  - e.g. extinct, extirpated, endangered, threatened, special concern
- The name of the species – both the common and scientific names
- Picture of the species – photograph or drawing
- Brief information about the species (“What does it look like? and Where was it last seen?”)
  - e.g. general description, distribution, habitats, general biology (tell me something interesting about the species)
- Information about why the species is at risk (“What happened?”)
  - what are the factors and how do they apply to the species.
  - e.g. A combination of hunting and habitat loss likely contributed to the initial decline in Dodo bird numbers. However, the flightless birds did not have a chance for survival against the animals that the humans brought with them to the island of Mauritius. The animals, including dogs, cats, and pigs, devoured the Dodo’s eggs, which were unfortunately for the Dodo laid in nests on the ground since the Dodo could not fly.
- Brief information about recovery initiatives that are/were in place to help preserve the species (“What is being done, or has been done, to help?”)
  - If the species is extinct, describe what recovery initiatives were in place to help the species before it became extinct.
- An evaluation of the recovery initiatives (“What do you think of what is being done to help?”)
  - e.g. Do you think that the recovery strategies will help preserve the species? Do the recovery strategies cover everything? Or, is there something more that should be done? If so, what is it?
  - If the species is extinct, describe what went wrong and why.

**Evaluation**

The MISSING! Poster will be evaluated in accordance with the Rubric on the following page. A mark will be awarded for each of the categories based on the descriptions of the levels of achievement for each category.

**References:**

1. List of Wildlife Species at Risk (Environment Canada)  
[http://www.sararegistry.gc.ca/default\\_e.cfm](http://www.sararegistry.gc.ca/default_e.cfm)
2. COSEWIC's Assessment Process and Criteria  
[http://www.cosewic.gc.ca/eng/sct0/assessment\\_process\\_e.cfm#tbl2](http://www.cosewic.gc.ca/eng/sct0/assessment_process_e.cfm#tbl2)
3. Species at Risk Act (SARA)  
[http://www.sararegistry.gc.ca/approach/act/default\\_e.cfm](http://www.sararegistry.gc.ca/approach/act/default_e.cfm)
4. A to Z Species Index (for the List of Wildlife Species at Risk)  
[http://www.sararegistry.gc.ca/sar/index/default\\_e.cfm](http://www.sararegistry.gc.ca/sar/index/default_e.cfm)
5. The Species at Risk Act and You  
[http://www.sararegistry.gc.ca/involved/you/default\\_e.cfm](http://www.sararegistry.gc.ca/involved/you/default_e.cfm)

## MISSING! Poster Rubric

Categories	Level 4 (Superior)	Level 3 (Adequate)	Level 2 (Minimal)	Level 1 (Inadequate)
<b>Content (20%)</b>	The poster includes all required elements, as well as additional information. All information is covered in thorough detail.	The poster includes all required elements. All information is covered in sufficient detail.	The poster includes most of the required elements. Most information is covered in sufficient detail.	Several of the required elements were missing. Information was not covered in sufficient detail.
<b>Organization (20%)</b>	Information was clearly divided into meaningful subtopics. The subtopics were presented in sequential and logical fashion.	Information was clearly divided into meaningful subtopics. The subtopics were presented in a mostly sequential and logical fashion.	Most of the information was divided into meaningful subtopics. The subtopics were presented in a somewhat sequential and logical fashion.	Information was not divided into meaningful subtopics. The subtopics were not presented in sequential and logical fashion.
<b>Creativity and Attractiveness (20%)</b>	The poster is exceptionally attractive in terms of design, layout, and neatness.	The poster is attractive in terms of design, layout, and neatness.	The poster is acceptably attractive, but somewhat lacking in design, layout and/or neatness.	The poster is unattractive, and the design, layout and neatness are poor.
<b>Understanding (20%)</b>	The student shows a thorough understanding of the impact of natural and external factors on the biodiversity of aquatic ecosystems. All factors were considered in relation to the species examined.	The student shows a considerable understanding of the impact of natural and external factors on the biodiversity of aquatic ecosystems. Most factors were considered in relation to the species examined.	The student shows some understanding of the impact of natural and external factors on the biodiversity of aquatic ecosystems. Some factors were considered in relation to the species examined.	The student shows a limited understanding of the impact of natural and external factors on the biodiversity of aquatic ecosystems. The factors were infrequently considered in relation to the species examined.
<b>Connections and Assessment (20%)</b>	The student identified and evaluated environmental initiatives with a high degree of effectiveness.	The student identified and evaluated environmental initiatives with considerable effectiveness.	The student identified and evaluated environmental initiatives with moderate effectiveness.	The student identified and evaluated environmental initiatives with limited effectiveness.

**MISSING!**

Rayed Bean  
(*Villosa fabalis*)

**(Mollusc)**

**MISSING!**

Kidneyshell  
(*Ptychobranchus fasciolaris*)

**(Mollusc)**

**MISSING!**

Round Pigtoe  
(*Pleurobema sintoxia*)

**(Mollusc)**

**MISSING!**

Northern  
Riffleshell  
(*Epioblasma torulosa*)

**(Mollusc)**

**MISSING!**

Channel Darter  
*(Percina copelandi)*

**(Freshwater Fish)**

**MISSING!**

Wavy-rayed  
Lampmussel  
*(Lampsilis fasciola)*

**(Mollusc)**

**MISSING!**

Deepwater Cisco  
*(Coregonus johannae)*

**(Freshwater Fish)**

**MISSING!**

Blue Walleye  
*(Sander vitreum glaucum)*

**(Freshwater Fish)**

**MISSING!**

Lake Chubsucker

*(Erimyzon sucetta)*

**(Freshwater Fish)**

**MISSING!**

Eastern Sand

Darter

*(Ammonocrypta pellucida)*

**(Freshwater Fish)**

**MISSING!**

Lake Ontario Kiyi

*(Coregonus kiyi orientalis)*

**(Freshwater Fish)**

**MISSING!**

Grass Pickerel

*(Esox americanus vermiculatus)*

**(Freshwater Fish)**



**MISSING!**

Pugnose Minnow  
*(Opsopoeodus emiliae)*

**(Freshwater Fish)**

**MISSING!**

Northern  
Madtom  
*(Noturus stigmosus)*

**(Freshwater Fish)**

**MISSING!**

Pugnose Shiner  
*(Notropis anogenus)*

**(Freshwater Fish)**

**MISSING!**

Paddlefish  
*(Polyodon spathula)*

**(Freshwater Fish)**

**MISSING!**

Silver Chub  
(*Macrhybopsis storeriana*)

**(Freshwater Fish)**

**MISSING!**

Spotted Car  
(*Lepisosteus oculatus*)

**(Freshwater Fish)**

**MISSING!**

Shortjaw Cisco  
(*Coregonus zenithicus*)

**(Freshwater Fish)**

**MISSING!**

Shortnose Cisco  
(*Coregonus reighardi*)

**(Freshwater Fish)**

**MISSING!**

Louisiana  
Waterthrush  
(*Seiurus motacilla*)

**(Bird)**

**(Bird)**

**MISSING!**

Prothonotary  
Warbler  
(*Protonotaria citrea*)

**(Bird)**

**MISSING!**

Least Bitterns  
(*Ixobrychus exilis*)

**(Bird)**

**MISSING!**

King Rail  
(*Rallus elegans*)

**MISSING!**

Small-mouthed  
Salamander  
(*Ambystoma texanum*)

**(Amphibian)**

**MISSING!**

Yellow Rail  
(*Coturnicops noveboracensis*)

**(Bird)**

**MISSING!**

Tiger Salamander  
(*Ambystoma tigrinum*)

**(Amphibian)**

**MISSING!**

Northern Cricket  
Frog  
(*Acris crepitans*)

**(Amphibian)**

**MISSING!**

Spiny Softshell  
*(Apalone spinifera)*

**(Reptile)**

**MISSING!**

Northern Map  
Turtle  
*(Graptemys geographica)*

**(Reptile)**

**MISSING!**

Spotted Turtle  
*(Clemmys guttata)*

**(Reptile)**

**MISSING!**

Queen Snake  
*(Regina septembittata)*

**(Reptile)**

**MISSING!**

American  
Water-willow  
(*Justicia americana*)

**(Vascular Plant)**

**MISSING!**

Stinkpot Turtle  
(*Sternotherus odoratus*)

**(Reptile)**

**MISSING!**

Engelmann's  
Quillwort  
(*Isoetes engelmannii*)

**(Vascular Plant)**

**MISSING!**

Lake Erie  
Water Snake  
(*Nerodia sipedon insularum*)

**(Reptile)**

**MISSING!**

Scarlet Ammannia  
(*Ammannia robusta*)

**(Vascular Plant)**

**MISSING!**

Swamp  
Rose-mallow  
(*Hibiscus moscheutos*)

**(Vascular Plant)**

**MISSING!**

Heart-leaved  
Plantain  
(*Plantago cordata*)

**(Vascular Plant)**

**MISSING!**

Hill's Pondweed  
(*Potamogeton hillei*)

**(Vascular Plant)**

# MISSING!

## Species Topics for Students

There are a total of 40 species topics for the students included on the following pages. The topics must be cut out so that one can be handed to each student.

All 40 are aquatic species in the Great Lakes region. Each species is on the “List of Wildlife Species at Risk” and has been listed with a SARA status of extinct, extirpated, endangered, threatened, or special concern. As such, there is a Schedule and Recovery Initiatives for each of the species. Information about each species, including a species profile and recovery initiatives can be found under the A to Z Species Index at the Species at Risk Public Registry website:

[http://www.sararegistry.gc.ca/sar/index/default\\_e.cfm](http://www.sararegistry.gc.ca/sar/index/default_e.cfm)

### Species (40 Total):

#### **Molluscs (5 Total)**

Kidneyshell (*Ptychobranhus fasciolaris*)  
Northern Riffleshell (*Epioblasma torulosa*)  
Rayed Bean (*Villosa fabalis*)  
Round Pigtoe (*Pleurobema sintoxia*)  
Wavy-rayed Lampmussel (*Lampsilis fasciola*)

#### **Freshwater Fish (15 Total)**

Blue Walleye (*Sander vitreum glaucum*)\*  
Channel Darter (*Percina copelandi*)  
Deepwater Cisco (*Coregonus johanna*)\*  
Eastern Sand Darter (*Ammonocrypta pellucida*)  
Grass Pickerel (*Esox americanus vermiculatus*)  
Lake Chubsucker (*Erinmyzon sucetta*)  
Lake Ontario Kiyi (*Coregonus kiyi orientalis*)\*  
Northern Madtom (*Noturus stigmosus*)  
Paddlefish (*Polyodon spathula*)  
Pugnose Minnow (*Opsopoeodus emiliae*)



Pugnose Shiner (*Notropis anogenus*)  
Shortjaw Cisco (*Coregonus zenithicus*)  
Shortnose Cisco (*Coregonus reighardi*)  
Silver Chub (*Macrhybopsis storeriana*)  
Spotted Car (*Lepisosteus oculatus*)

**Birds (5 Total)**

King Rail (*Rallus elegans*)  
Least Bitterns (*Ixobrychus exilis*)  
Louisiana Waterthrush (*Seiurus motacilla*)  
Prothonotary Warbler (*Protonotaria citrea*)  
Yellow Rail (*Coturnicops noveboracensis*)

**Amphibians (3 Total)**

Northern Cricket Frog (*Acris crepitans*)  
Small-mouthed Salamander (*Ambystoma texanum*)  
Tiger Salamander (*Ambystoma tigrinum*)

**Reptiles (6 Total)**

Northern Map Turtle (*Graptemys geographica*)  
Queen Snake (*Regina septembittata*)  
Spiny Softshell (*Apalone spinifera*)  
Spotted Turtle (*Clemmys guttata*)  
Stinkpot Turtle (*Sternotherus odoratus*)  
Lake Erie Water Snake (*Nerodia sipedon insularum*)

**Vascular Plants (6 Total)**

American Water-willow (*Justicia americana*)  
Engelmann's Quillwort (*Isoetes engelmannii*)  
Heart-leaved Plantain (*Plantago cordata*)  
Hill's Pondweed (*Potamogeton hillei*)  
Scarlet Ammania (*Ammannia robusta*)  
Swamp Rose-mallow (*Hibiscus moscheutos*)

**\*Species marked with an asterisk are extinct. These species may be provided to students that might have more difficulty with this assignment. In general, it is easier to find information on extinct species and the evaluation of recovery initiatives is more straightforward.**